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(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 806 786 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.11.1997 Bulletin 1997/46

(21) Application number: 97300660.4

(22) Date of filing: 31.01.1997

(51) Int Cl.[6]: H01J 9/227, H01J 17/49

(84) Designated Contracting States:
DE FR GB

(30) Priority: 09.05.1996 JP 114884/96
17.12.1996 JP 337189/96

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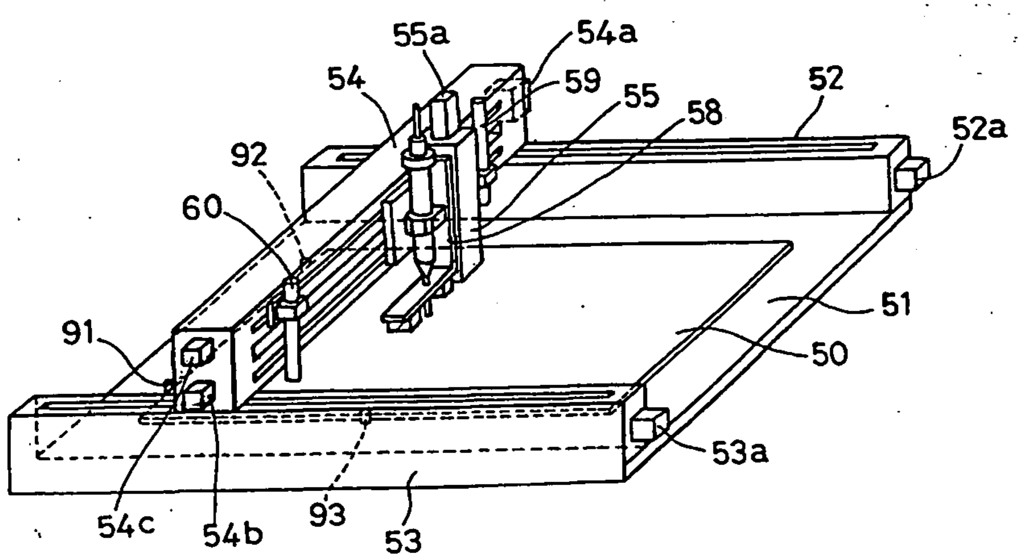
(54) **Apparatus for and method of manufacturing fluorescent layers for plasma display panels**

(57) An apparatus for forming the fluorescent layers of plasma display panels by applying to a substrate a fluorescent paste into grooves formed between a plurality of ribs on such a substrate, the apparatus comprising a platform (51) for mounting a substrate (50), a dispenser (58) having at least one nozzle for ejecting the fluorescent paste and a transporter (52-55) for moving the nozzle relative to the platform (51).

Fig.2



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Description

The present invention relates to an apparatus for forming the fluorescent layers of a plasma display panel, a method therefor and to plasma display panels and their substrates.

More particularly, the present invention relates to an apparatus which is used in manufacturing a plasma display panel (PDP) and which forms, on a substrate having a plurality of ribs (partition walls) on the surface thereof, a fluorescent layer in each of the spaces formed between the ribs, a method therefor, a plasma display panel and a substrate therefor.

A PDP is a display panel having, as a base, a pair of substrates (typically, glass plates) disposed opposite to each other with a discharge space sandwiched therebetween. In a PDP, by disposing a fluorescent layer of an ultraviolet-ray excitation type in the discharge space, it is possible to display a color since the fluorescent layer is excited by electric discharge. PDPs for displaying colors generally have three fluorescent layers of R (red), G (Green), and B (Blue).

Conventionally, fluorescent layers of R, G, and B were manufactured by successively applying, on a substrate, fluorescent pastes for the three colors containing powder-like fluorescent particles as a major component by screen printing method, followed by drying and sintering (for example, see Japanese Unexamined (Kokai) Patent Publication No. Hei 5(1993)- 299019).

However, as the screen size of PDPs increase, an alignment shift is brought about between a positioning pattern and a mask pattern of the ribs due to the expansion and contraction of the screen mask. This causes errors in positioning and the like, so that it is becoming more and more difficult to achieve precise application of the fluorescent pastes between the ribs as PDPs become larger.

It is thus difficult with existing apparatus to form fluorescent layers uniformly and precisely between the ribs on the substrate, when constructing a large area PDP.

According to a first aspect of the invention there is provided an apparatus for forming a fluorescent layer in a plasma display panel by applying a fluorescent paste into grooves formed between a plurality of ribs disposed in parallel on a surface of a substrate, the apparatus comprising: a platform for mounting the substrate thereon; a dispenser having at least one nozzle for ejecting the fluorescent paste; a transporter for moving the nozzle relative to the platform; and a controller for controlling the transporter and the dispenser so that the fluorescent paste is consecutively applied into the predetermined grooves between the ribs.

According to a second aspect of the invention there is provided a method for consecutively applying a plurality of fluorescent pastes having different colors into grooves formed between a plurality of ribs disposed in parallel on a substrate surface, the different colors including at least first and second colors, the method comprising the steps of: preparing a plurality of fluorescent layer forming apparatus each ejecting a fluorescent paste of each color; applying the fluorescent paste of the first color into first grooves on the substrate surface with one of the fluorescent layer forming apparatus, the first grooves corresponding to the fluorescent paste of the first color; drying the fluorescent paste of the first color applied into the first grooves to such a degree that at least no surface tension is generated; applying the fluorescent paste of the second color subsequently with another of the fluorescent layer forming apparatus into second grooves adjacent the first grooves on the substrate, the second grooves corresponding to the fluorescent paste of the second color; and drying the fluorescent paste of the second color applied into the second grooves to such a degree that at least no surface tension is generated, and alternately repeating the steps of applying and drying the fluorescent paste of each color.

Fluorescent paste can thus be ejected from a nozzle moving over a substrate so as to be applied into the grooves between the ribs without the use of a conventional screen mask and by simply setting the substrate design numerically. Therefore, it is possible to form fluorescent layers accurately on a substrate of any size and to easily comply with a change in substrate design.

According to a third aspect of the invention there is provided a plasma display panel manufactured with the apparatus of the first aspect of the invention or following the method of the second aspect of the invention.

Further aspects of the invention are exemplified by the attached claims.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Fig. 1 is a perspective view showing a plasma display panel manufactured according to an embodiment of the present invention;
Fig. 2 is a perspective view showing an apparatus for manufacturing a plasma display panel according to a first embodiment;
Fig. 3 is a plan view of the apparatus of Fig. 2;
Fig. 4 is a front view of the apparatus of Fig. 2;
Fig. 5 is a block diagram showing a controller for the embodiment of Fig. 2;
Fig. 6 is a flow chart showing operation of a method according to a first embodiment;
Fig. 7 is a top view showing a substrate for manufacture into a display panel with the manufacturing apparatus and/or method of the first embodiment;
Fig. 8 is an enlarged view of the substrate of Fig. 7;
Fig. 9 is an enlarged view similar to Fig. 8 but of a modified substrate to which the manufacturing apparatus and/or method of the first embodiment may be applied;
Fig. 10 is a top view showing a further modified substrate;

Fig. 11 is an enlarged view showing a still further modified substrate for correcting the rib pitch as compared with the substrate of Fig. 7;
Fig. 12 is a graph showing the relationship between the clearance and the ejected amount of the fluorescent paste;
Fig. 13 is a schematic view of a production line for manufacturing plasma display panels according to embodiments of the invention;
Fig. 14 is a schematic view of another production system for manufacturing plasma display panels according to embodiments of the present invention;
Fig. 15 is a perspective view showing a multi-nozzle paste dispenser according to modified embodiments of the present invention;
Fig. 16 is a cross-sectional view of the nozzle shown in Fig. 15;
Fig. 17 is a top view showing the positional relationship between the ends of the ribs of a plasma display panel and the location at which the application of the fluorescent paste is finished;
Fig. 18 is a top view showing a substrate having modified ribs;
Fig. 19 is a side view showing a nozzle having a modified tip;
Fig. 20 is a perspective view showing an applicator head incorporating a nozzle according to a further embodiment;
Fig. 21 is a longitudinal cross-sectional view of the applicator head shown in Fig. 20; and
Fig. 22 is a cross-sectional view along the line A-A of Fig. 21.

A plasma display panel (PDP) is constructed such that an electric discharge is locally generated between a pair of opposing substrates so that the partitioned fluorescent layers on the substrate are excited to emit light. A PDP can be constituted, for example, by a pair of substrate assemblies 50, 50a shown in Fig. 1 (for one pixel).

In the substrate assembly 50a, a pair of sustaining electrodes X, Y are arranged for each line on the inside surface of a front-side glass substrate 11 for generating a surface discharge along the substrate surface. Each of the sustaining electrodes X, Y includes a wide linear band-like transparent electrode 41 made of a thin ITO film and a narrow linear band-like bus electrode 42 made of a thin metal film.

The bus electrode 42 is an auxiliary electrode for securing a proper electric conductivity. A dielectric layer 17 is provided so as to cover the sustaining electrodes X, Y. A protective film 18 is deposited by vaporization on the surface of the dielectric layer 17. Both the dielectric layer 17 and the protective film 18 have a light transmission property.

In the substrate assembly 50, address electrodes A are arranged on the inside surface of the rear-side glass substrate 21 so that the address electrodes A are perpendicular to the sustaining electrodes X, Y. A linear rib r is disposed in each interval formed between two adjacent address electrodes A. In other words, ribs r and address electrodes A are alternately disposed.

In the substrate assembly 50 (hereafter referred to as "substrate"), these ribs r serve to partition the electric discharge space 30 in the line direction for each subpixel (light emitting region unit) EU and define the gap dimension of the discharge space 30.

Fluorescent layers 28 for displaying three colors R, G and B are disposed so as to cover the rear-side walls including the upper portion of the address electrodes A and the side surface of the ribs r.

The ribs r are made of a low melting point glass and are opaque against ultraviolet rays. The ribs r may be formed through a process of providing an etching mask by photolithography on a solid-film low melting point glass layer to carry out patterning with a sandblast. The arrangement of the plurality of ribs to be formed in this process are determined by the pattern of the etching mask. Top views of the substrates showing preferable arrangements of the ribs are given in Figs. 8, 9 and 18. Fig. 8 shows a parallel arrangement in which the ribs are arranged in parallel with each other. Fig. 9 shows an arrangement in which the ribs meander. Fig. 18 shows an arrangement in which a plurality of ribs r having a straight central portion and opposite ends bent in opposite directions are arranged on the substrate so that two adjacent ribs r diverge from one another at one end of the groove therebetween and approach one another at the other end of the groove, being mutually parallel along the central portion thereof.

Each pair of sustaining electrodes 12 corresponds to a line of the matrix display. Each address electrode A corresponds to a row. Three rows correspond to one pixel (picture element) EG. In other words, one pixel EG includes three subpixels EU arranged in the line direction, each subpixel representing one of the three colors R, G and B.

An electric discharge generated between the address electrode A and the sustaining electrode Y controls the state of accumulated wall charge in the dielectric layer 17. Application of sustaining pulses alternately onto sustaining electrodes X, Y induces generation of surface discharge (main discharge) in a subpixel EU where a certain amount of wall charge is present.

Being excited locally by the ultraviolet rays generated through the surface discharge, the fluorescent layers 28 emit visible light of respective colors. This visible light, transmitted through the glass substrate 11, forms the displaying light. Since the arrangement pattern of the ribs 29 is what is known as a stripe pattern, the portion of the discharge space 30 corresponding to each row is continuous along the row and extends over all the lines. The emitted color of a subpixel EU in each row is the same.

In manufacturing such a PDP, the fluorescent layers are formed in a fluorescent layer forming apparatus after the address electrodes A and the ribs 29 are formed on

the substrate 21, as shown in Fig. 1. The platform for mounting the substrate in a fluorescent layer forming apparatus may be any platform by which a substrate can be releasably held, generally in an approximately horizontal plane.

The paste-like fluorescent substance (fluorescent paste) for forming the fluorescent layers is, for example, a mixture of a fluorescent substance for each color concerned at 10 to 50 wt%, ethyl cellulose at 5 wt% and BCA at 45 to 85 wt%.

The fluorescent substance for red may be, for example, (Y, Gd) BO_3 : Eu. The fluorescent substance for green may be, for example, Zn_2SiO_4 : Mn or $BaAl_{12}O_{19}$: Mn. The fluorescent substance for blue may be, for example, 3 (Ba, Mg) O·8 Al_2O_3 : Eu.

Referring to the nozzle of the dispenser for ejecting the fluorescent paste, the aperture size, e.g. inner diameter, of the nozzle is set so as to be smaller than the interval between adjacent ribs. However, since the tip of the nozzle is not inserted between the ribs, the outer diameter of the nozzle is not critical and may be larger than the interval between adjacent ribs. For example, if the interval between the ribs is 170 μm, the nozzle may conveniently have an inner diameter of about 100 μm and an outer diameter of about 300 μm. A multi-nozzle dispenser may be used in which a plurality (for example, 5 to 30) of nozzles are arranged with a predetermined coating pitch along the direction perpendicular to the ribs. In such a case, a plurality of grooves can be coated simultaneously.

The fluorescent paste dispenser for supplying fluorescent pastes into the grooves may include in addition to its nozzle or nozzles, a vessel (syringe) connected to the rear end of the nozzle for holding the paste-like fluorescent substance and a pressure generator for pressing the fluorescent substance out of the vessel and through the nozzle. A commercially available dispenser (for example, System C Type manufactured by Musashi Engineering Co., Ltd. in Japan) may be used.

The transporter to be used may be one in which the nozzle and the platform are moved relative to each other so that the tip of the nozzle can be moved in three directions, namely, in the directions parallel to and perpendicular to the substrate ribs, and in the direction perpendicular to the substrate (height direction). Typical examples of the transporter are a three-axis robot and a three-axis manipulator.

A motor, an air cylinder, a hydraulic cylinder or the like may be used as a driving force source for driving each of the axes. However, in view of the facility and accuracy of control, preferred embodiments use a stepping motor or a servomotor equipped with an encoder.

The controller for controlling the moving operation of the transporter and the ejecting operation of the nozzle may comprise a microcomputer and a driver circuit. The microcomputer may include a CPU, a ROM and an I/O port. The driver circuit is operable to drive the driving force source of the nozzle transporter. A keyboard, a tablet, a mouse or the like may be used as the input section for setting the controlling conditions of the controller.

In use, a substrate with a plurality of parallel linear ribs formed on a surface thereof at a predetermined pitch is mounted on the apparatus platform. Subsequently, fluorescent layers are formed in each of the grooves between adjacent ribs by ejecting fluorescent paste from the tip of the nozzle while moving the nozzle relative to the substrate.

If fluorescent pastes having different colors are to be applied into two adjacent grooves, there is the danger that the two fluorescent pastes will be brought into contact and mix with each other by surface tension if a groove is filled with one fluorescent paste immediately after the adjacent groove has been filled with another fluorescent paste. Therefore, it is preferable to dry sufficiently paste of one color applied to a first set of grooves before paste of another color is applied to grooves lying adjacent to the first set of grooves.

The relevant conditions regarding the position and the dimension of the ribs such as the rib shape (linear or meandering shape), the rib length, the rib height, the pitch of arranged ribs, the number of arranged ribs and the positions (coordinates) of the starting point and the end point of application on the substrate, as well as the conditions regarding the nozzle such as the moving speed of the nozzle, the distance between the tip of the nozzle and the substrate (or the top of the rib) and the amount of ejected fluorescent paste per hour are set in the apparatus, for example programmed in by a user based on the input from the input section. This allows the controller to move the nozzle relative to the substrate in accordance with the set rib positions and rib dimensions.

In a preferred embodiment, the fluorescent layer forming apparatus includes an optical sensor for detecting alignment marks provided on the surface of the substrate. Detection of alignment marks enables and facilitates procedures for recognition and correction of the nozzle position relative to the substrate position or rib position. An example of a suitable optical sensor is one based on a CCD camera.

If an optical sensor is used, alignment marks are formed in advance on the substrate surface corresponding to the position where the ribs are to be formed. In view of efficiency and accuracy, this step of forming the alignment marks is performed in preferred embodiments simultaneously with the formation of the ribs.

In other words, if the ribs are formed for example by a printing method, the alignment marks can be simultaneously formed by the printing method. Similarly, if the ribs are formed for example by a sandblast method, the alignment marks can be simultaneously formed by the sandblast method.

The controller is then able to detect the alignment marks that are thus formed and read the coordinates thereof e.g. in advance of paste applications by the optical sensor. In the coating process, the controller can

thus judge the position and the pitch of each rib to move the nozzle or to modify the previously set position of the rib based on the alignment marks.

Here, alignment marks may be provided either for each rib or for each prescribed number of ribs. By providing alignment marks at the desired starting position and finishing position of the paste application, it is possible to accurately control the movement of the nozzle or nozzles in a convenient manner. The optical sensor may detect the front tip of the rib instead of the alignment mark. If the front tip of the rib is to be detected, it is preferable that dark ribs are formed by mixing a colorant such as a black pigment into the rib material so as to provide a greater difference in brightness between the ribs and the grooves.

Referring to Fig. 12, the amount Q ejected from the nozzle tends to increase as the distance C (hereafter referred to as "clearance") between the tip of the nozzle and the substrate (or the top of the rib) increases. Accordingly, it is preferable to keep the clearance constant in the coating step.

Here, a suitable value for the clearance C is determined having regard to the viscosity of the fluorescent paste and the amount of the contained fluorescent substance. The clearance C is usually 100 to 200 μm. Conversely, by utilizing the above property, the amount Q ejected from the nozzle may be controlled by the clearance C.

Further, when the fluorescent paste is ejected between the ribs from the tip of the nozzle, it has been confirmed that, once the application is started, the fluorescent paste is pulled back to its normal position by its surface tension even when the tip of the nozzle is shifted a little bit from the normal application position.

Utilizing this property, it is possible to carry out the application operations smoothly by starting the application with small clearance (that is, with a small amount of ejection) and restoring the clearance to the previously set distance after a predetermined time has passed so as to restore the ejected amount to the previously set value.

Accordingly, the application or coating step preferably includes a starting coating step for applying a fluorescent paste while maintaining the distance between the tip of the nozzle and the substrate to be a first distance, and a subsequent stationary coating step for applying the fluorescent paste while maintaining the distance between the tip of the nozzle and the substrate to be a second distance which is larger than the first distance.

Alternatively, an effective display region may be provided at a portion (a central portion) of the substrate surface and an ineffective display region may be provided at a portion (a periphery) of the substrate surface adjacent the effective region, whereby the starting coating step is carried out in the ineffective display region and the stationary coating step is carried out in the effective region.

Since the clearance C varies in accordance with the warping of the substrate or the variation in rib height, the clearance C must be corrected for each substrate. Correction of the clearance C can be performed by measuring the height of the surface of the substrate (or the rib) at one or more arbitrary points on the substrate surface. If three or more such points are measured (and are not all colinear) then it is possible to calculate a virtual curved surface (a spline curved surface) connecting the points so that the tip of the nozzle can be moved with a clearance C calculated from the virtual curved surface.

Accordingly, if the apparatus further comprises a height sensor for measuring the height of an arbitrary point on the substrate surface from the platform, the method for forming fluorescent layers may preferably comprise a step of measuring the height of three arbitrary points on the substrate surface and a step of establishing a virtual curved surface connecting the measured points, whereby the tip of the nozzle can be moved parallel to the virtual curved surface during paste application.

Here, the height sensor may for example be a known optical sensor for determining the distance to an object by emitting a light from a laser diode to the object after high frequency modulation and comparing the phase of the reflected modulated wave with that of a standard wave.

Figs. 2, 3 and 4 are a perspective view, a plan view and a front view respectively of an apparatus for forming fluorescent layers for a 42-inch color PDP. Fig. 5 is a block diagram of a control circuit for the apparatus.

Referring to these figures, pins 91 to 93 for positioning the substrate 50 are disposed to stand upright on the platform 51 for mounting the substrate 50, and a sucking apparatus (not shown) is provided for fixing the substrate 50 onto the platform 51 by sucking.

A pair of Y-axis oriented transporters (hereafter referred to as "Y-axis robots) 52, 53 are disposed on both sides of the platform 51. An X-axis oriented transporter (hereafter referred to as "X-axis robot") 54 is mounted onto the Y-axis robots 52, 53 so that the X-axis robot is movable in a direction shown by arrows Y-Y'. A Z-axis oriented transporter (hereafter referred to as "Z-axis robot") 55 is mounted onto the X-axis robot 54 so that the Z-axis robot is movable in a direction shown by arrows X-X'. On the Z-axis robot 55 is mounted a syringe attachment 58 for detachably attaching a dispenser including a nozzle 56 for ejecting a fluorescent paste and a syringe 57, so that the syringe attachment 58 is movable in a direction shown by arrows Z-Z'.

Position sensors 59, 60 for detecting the alignment marks on the surface of the substrate 50 are each independently mounted on the X-axis robot 54, so that the sensors 59, 60 are movable in a direction shown by the arrows X-X'. Height sensors 61, 62 are provided for measuring the distance C (the clearance) from the tip of the nozzle 56 to the top of the rib and for measuring the

distance from the tip of the nozzle 56 to the surface of the fluorescent paste after the fluorescent paste is applied. The height sensors 61, 62 are fixed onto the foot of the syringe attachment 58 so that the nozzle 56 is positioned between the height sensors 61, 62.

The X-axis robot 54 is transported by Y-axis motors 52a, 53a in the Y-axis robots 52, 53. The Z-axis robot 55 is transported by an X-axis motor 54a in the X-axis robot 54. The position sensors 59, 60 are transported by sensor motors 54b and 54c respectively. The syringe attachment 58 is transported by a Z-axis motor 55a in the Z-axis robot 55.

Referring to Fig. 5, the controller 80 includes a microcomputer having a CPU, a ROM and a RAM, and controls and drives the X-axis motor 54a, the Y-axis motors 52a, 53a, the Z-axis motor 55a, the sensor motors 54b, 54c and an air controller 72 on receiving the output from the keyboard 81, the position sensors 59, 60 and the height sensors 61, 62. The controller 80 also drives the CRT 82 to display in characters and images the various conditions inputted from the keyboard 81 and the progress of the operation of applying the fluorescent paste.

Air pressure from an air source 70 (for example, an air bomb) is applied to the air controller 72 via an air tube 71. On receiving the output from the controller 80, the air controller 72 applies the air pressure to the syringe 57 via the air tube 73 to keep the amount ejected from the nozzle 56 to be constant.

The procedure for forming fluorescent layers on a substrate for a 42-inch PDP will be hereinafter explained in conjunction with the flow chart shown in Fig. 6.

First, the syringe 57 containing 20 cc of a fluorescent paste for forming red (R) fluorescent layers is attached together with the nozzle 56 to the syringe attachment 58.

Referring to Fig. 7, the substrate 50 having an ineffective display (dummy) region 50b around the effective display region 50a is mounted and fixed at a predetermined position on the platform 51 (step S1).

The substrate 50 consists of a glass plate having a thickness of about 3.0 mm. On the effective display region 50a of the substrate 50 are formed, in advance, 1921 ribs r having a length of L = 560 mm, a height of H = 100 μm and a width of W = 50 μm and being parallel to the direction shown by the arrows X-X' with a pitch P, as shown in Fig. 8. On the dummy region 50b are formed, in advance, an alignment mark M1 indicating the beginning position for paste application, an alignment mark M2 indicating the center of the substrate and an alignment mark M3 indicating the end position for paste application, as shown in Fig. 7. Since 1920 grooves are formed on the substrate 50 by 1921 ribs r, the fluorescent materials R, G and B are each applied on 640 (1920/3) grooves respectively.

At the time of fixing the substrate, the set values such as the rib height H, the rib width W, the number N of the ribs, the clearance C, the amount Q ejected from the nozzle, the thickness of the fluorescent paste to be applied, the velocity V of nozzle movement and the coordinates of the height detection regions R1 to R9 (See Fig. 7) are inputted from the keyboard 81.

When the keyboard 81 is operated, the controller 80 detects the condition of the substrate and performs calculation operations (step S2). Specifically, by driving the X-axis robot 54 and the Y-axis robots 52 and 53, the controller 80 reads the position of the alignment mark M2 via the position sensor 59 and reads the positions of the alignment marks M1, M3 via the position sensor 60.

The controller 80 then detects, via the height sensor 61, the points P1 to P9 having the maximum substrate height (the height from the platform 51) in the set regions R1 to R9 respectively. Further, the controller 80 calculates coordinates of the starting point for application, the application pitch P, the spline curved surface passing through the points P1 to P9, and the like. Here, the pitch P is calculated from the distance between the marks M1 and M2 and the number N of the ribs.

Then, the operator attaches to the syringe attachment 58 a syringe (with a nozzle) containing a red fluorescent paste (hereafter referred to as "R fluorescent paste") as a syringe 57 and a nozzle 56 (step S4). When the starting operations are performed on the keyboard 81 (step S5), the tip of the nozzle 56 is moved, based on the alignment mark M1, to the starting point for applying the R fluorescent paste and is maintained at a predetermined height (the clearance) (step S6).

The nozzle 56 then begins to eject the R fluorescent paste and, at the same time, moves in the direction shown by the arrow X, thereby starting the operation of applying the fluorescent paste (step S7). When the nozzle 56 moves by the length L of one rib, the nozzle 56 stops performing the ejecting and moving operations (operation of applying the fluorescent paste) (step S8 and step S9).

The nozzle 56 then moves for a pitch 3P in the direction shown by the arrow Y and begins the ejecting operation and the moving operation in the direction shown by the arrow X' (steps S10 to S12). After moving by length L, the nozzle 56 stops the ejecting and moving operations and moves for a pitch 3P in the direction shown by the arrow Y (steps S13 to S16). The nozzle 56 repeats the operations in the steps S7 to S16 and, when the number of coated grooves reaches 640 in the step S10 or S15, the work with the R fluorescent paste is completed.

The operator then replaces the syringe 57 and the nozzle 56 with those for green fluorescent paste (hereafter referred to as "G fluorescent paste") and repeats the operations in the steps S5 to S16 (steps S17, S18). After the coating of 640 grooves with the G fluorescent paste is finished, the syringe 57 and the nozzle 56 are replaced with those for a blue fluorescent paste (hereafter referred to as B fluorescent paste) and the coating of 640 grooves with the B fluorescent paste is conducted

in the same manner as mentioned above (steps S19, S20).

Here, the above coating operation is stopped so that a portion coated with the fluorescent paste 28 in each of the grooves is shorter than the groove by a predetermined distance d, as shown in Fig. 17. This is for preventing the applied fluorescent paste from being extended around the ends of the ribs r into an adjacent groove. In this case, it has been experimentally shown that a distance d of more than 0.5mm prevents this extension.

The coating operation of the above embodiment is constructed in such a manner that, on finishing the application of the fluorescent paste into one groove, the nozzle 56 is moved in the direction shown by arrow Y by a predetermined pitch 3p so as to start the application of the fluorescent paste into the next groove. Alternatively, however, the coating operation may be performed by detecting, with the position sensors 59, 60, the front end and the rear end respectively of the rib forming the next groove to be coated every time the coating operation of one groove is finished and by moving the nozzle 56 on the basis of the detected front and rear ends of the rib. This further improves the precision of applying the fluorescent paste into each groove. In this case, if the position sensors 59 and 60 cannot detect the front end or the rear end of the rib for whatever reason (for example, a partial destruction of the rib end), the coating operation of applying the fluorescent paste into the next groove is performed on the basis of the predetermined rib pitch without discontinuing the coating operation.

When all the operations for forming R, G and B fluorescent layers fitted onto the interior surface of the grooves between the ribs as shown in Fig. 1 are finished, the X-axis robot 54 returns to the home position (the position nearest to the upper perimeter of the platform 51 in the direction shown by the arrow Y' in Fig. 3). The operator then discharges the substrate 50 (step S21). The fluorescent paste on the discharged substrate 50 is dried in the subsequent step.

Here, in the above operation of applying the fluorescent paste, the tip of the nozzle 56 is maintained by the Z-axis robot 55 at a height such that the tip of the nozzle 56 is always away by the clearance C = 100 μm from the calculated spline curved surface.

While the coating operation is performed in the directions shown by arrows X and X', the controller 80 watches the surface height (the thickness) of the fluorescent paste immediately after the application with the height sensor 62 and the height sensor 61 respectively. When the thickness of the applied fluorescent paste measured by the height sensors 62 and 61 deviates from a predetermined permissible range, the controller 80 immediately stops the coating operation (ejection and movement) of the nozzle 56. The controller 80 then triggers an alarm indicating "poor application" and displays the coordinates of the position of the stopped nozzle 56 on the CRT 82. The controller 80 also stores the coordinates into the built-in RAM.

After the cause of the poor application (for example, the clogging of the nozzle) is removed, the operator replaces the substrate 50 on the platform 51 with a new one to start the coating operation again (steps S1 to S21).

This enables poor application of the fluorescent paste to be detected much earlier than by the conventional method of inspecting the substrate after the three colors of R, G and B have been applied and the drying step has been finished. Therefore, the efficiency and the yield in applying the fluorescent paste is improved. Also, since the RAM stores the position (coordinates) at which the interruption due to "poor application" has occurred on the substrate, it is easy to perform a repair or reapplication operation on the substrate.

In this Example, the substrate 50 used has a plurality of ribs r independently formed on the surface as shown in Fig. 8. Alternatively, however, a substrate may be used in which the ends of the adjacent ribs are alternately connected with each other as shown in Fig. 9. According to such a rib shape, the bridging or connecting portion at the rib ends becomes an end position of coating for each fluorescent paste, so that webbing (stringing) of the fluorescent paste at this portion can be prevented.

Alternatively, the substrate may have ribs r such that adjacent ribs diverge from each other at one end of the groove between the ribs and approach each other at the other end of the groove, as shown in Fig. 18, and the coating operation is started at the wider end of the groove and is finished at the narrower end of the groove. This helps ensure that the fluorescent paste 28 is easy to introduce into the groove at the start of the coating operation for that groove and is prevented from being forced out of the groove at the end of the coating operation for that groove.

In this Example, the alignment marks M1 and M3 are detected for calculating the pitch P of the ribs r. Alternatively, however, auxiliary alignment marks m may be provided for every predetermined number of ribs, as shown in Fig. 10, and a pitch P of the ribs may be set in advance before the coating operations so that the pitch P may be corrected by the detection of the marks m with the position sensor 59 or 60 during the coating operations. The alignment marks M1, M2, M3 and m are formed simultaneously when the ribs r are formed on the substrate 50.

Alternatively, the pitch P may be set in advance before the coating operations and the position of the last rib to be coated may be calculated from the pitch P. The nozzle 56 is moved to the coordinate point corresponding to the rib as shown in Fig. 11 to draw a point T with the fluorescent paste. The coordinates of the point T and the coordinates of the alignment mark M3 are detected by the position sensor 60. The set pitch P is corrected by their distance difference AL.

Fig. 13 is a view for explaining a construction of a

system utilizing the apparatus shown in Fig. 2, in which an apparatus 100R for forming R fluorescent layers, a drying furnace 200a, an apparatus 100G for forming G fluorescent layers, a drying furnace 200b, an apparatus 100B for forming B fluorescent layers and a drying furnace 200c are connected in series via conveyors 300a to 300e. The apparatus 100R for forming R fluorescent layers, the apparatus 100G for forming G fluorescent layers and the apparatus for forming B fluorescent layers are all similar to the fluorescent layer forming apparatus shown in Fig. 2. In this example, however, the respective syringes 57 contain a red, a green and a blue fluorescent paste respectively.

In this construction, after 640 red fluorescent strips are formed on the surface of the substrate 50 (Fig. 7) by the apparatus 100R, the substrate 50 is transported to the drying furnace 200a by the conveyor 300a to be dried. The dried substrate 50 is transported to the apparatus 100G by the conveyor 300b for forming 640 green fluorescent strips on the surface of the substrate 50.

The substrate 50 is then transported to the drying furnace 200b by the conveyor 300c to be dried. The dried substrate 50 is transported to the apparatus 100B by the conveyor 300d for forming 640 blue fluorescent strips on the surface of the substrate 50.

The substrate 50 is further transported to the drying furnace 200c by the conveyor 300e to be dried. Subsequently, the substrate 50 is sintered with a sintering apparatus (not shown) to complete the R, G and B fluorescent layers fitted onto the interior surface of the grooves between the ribs 29 as shown in Fig. 1.

In the drying furnaces 200a to 200c, the fluorescent paste which fills the grooves on the substrate 50 is dried at a temperature of 100 to 200°C for 10 to 30 minutes. The drying processes are conducted immediately after the fluorescent paste for each color is applied into the grooves because of the following reason. If the adjacent fluorescent paste previously applied is still in a liquid state, the fluorescent paste subsequently applied is liable to mix over the adjoining rib with the previously applied fluorescent paste via a surface tension effect, thus causing a mixed color. By subjecting the substrate to a drying step, the fluorescent paste filling the grooves between the ribs is fitted onto the interior surface of the grooves, thereby losing its surface tension. For the drying furnaces 200a to 200c, a hot plate method, a circulated hot air method or a far infrared light method can be employed either individually or in combination.

Fig. 14 is a view for explaining a construction of another system utilizing an apparatus as shown in Fig. 2. In this embodiment, one drying furnace 200 is provided instead of the three drying furnaces 200a to 200c as shown in Fig. 13. Instead of the conveyors 300a to 300e, a transporting robot 300 is provided for transporting the substrate 50 in a direction shown by arrows A-A' and in a direction shown by arrows B-B'.

In this construction, the substrate 50 is transported to the drying furnace 200 by the transporting robot 300 to be dried every time a fluorescent paste of each color is applied to the grooves in the same manner as in the system shown by Fig. 13.

Fig. 15 and Fig. 16 are a perspective view and a cross-sectional view showing a multi-nozzle as a modification of the syringe 57 and the nozzle 56 referred to in each of the above-described Examples.

In this multi-nozzle, six nozzles 56a are arranged in a line for each syringe 57a with a pitch six times longer than the rib pitch P.

When a fluorescent paste is applied, the fluorescent paste contained in the syringe 57a is ejected through the six nozzles 56a simultaneously. Therefore, six fluorescent layers of a color are formed at a time, thereby curtailing the time required for the coating operations by one sixth (1/6) as compared with the previously described Examples.

Now, the relationship between the rib pitch P, the nozzle pitch P_N and the amount of movement of the nozzle in the Y direction will be explained when a multi-nozzle is used having n nozzles arranged in a line at a pitch of P_N per each syringe. (Here, it is assumed that the fluorescent pastes are provided in three colors of R, G, and B).

<u>[A] The case where the fluorescent paste is applied while the nozzle is being moved in forward and backward directions</u>

The substrate shown in Fig. 8, Fig. 9 or Fig. 18 (especially the substrate having ribs in which the ends of the adjacent ribs are alternately open as shown in Fig. 9 or Fig. 18) may be used. The pitch P_N of nozzle arrangement is set so that P_N is 6P and the coating operation is carried out as follows.

(1) Applying the fluorescent paste simultaneously into grooves at an application pitch of 6P while moving the nozzle in the X direction from the open guide (the opening of the first groove) of the end pattern of the rib,
(2) Moving the nozzle in the Y direction by a distance of 3P so as to locate the nozzle at an open side of the end pattern of the rib (the opening of the second groove),
(3) Applying the fluorescent paste newly into n grooves while moving the nozzle in the X' direction (through the above steps, the fluorescent paste has been applied into 2n grooves at a pitch of 3P),
(4) Moving the nozzle in the Y direction by a distance of 3P X (2n-1) so as to locate the nozzle at the opening of the third groove.

The above steps (1) to (4) are repeated.

[B] The case where the fluorescent paste is applied while the nozzle is being moved in one direction

The substrate shown in Fig. 8 may be used. The pitch P_N of nozzle arrangement is set so that P_N is 3P and the coating operation is carried out as follows.

(1) Applying the fluorescent paste simultaneously into n grooves at an application pitch of 3P while moving the nozzle in a forward direction (in the X direction or in the X' direction),
(2) Moving the nozzle in a backward direction without applying the fluorescent paste so as to return the nozzle to the point of starting the application of the fluorescent paste,
(3) Moving the nozzle in the Y direction by a distance of 3P X n.

The above steps (1) to (3) are repeated.

In this manner, when the coating operation is carried out simultaneously with a plurality of nozzles 56a, it is difficult to apply the fluorescent paste uniformly and accurately into the groove corresponding to each nozzle if the end surface of the tip of the nozzle is perpendicular to the axis of the nozzle, even though the pitch of the nozzle is set to coincide with the rib pitch with high precision. This is because the fluorescent paste cannot be easily ejected immediately under the tip of the nozzle due to the viscosity and the surface tension of the fluorescent paste.

Therefore, when a plurality of nozzles are to be used, it is preferable that each of the nozzles has an end surface formed at an acute angle of θ relative to the axis of the nozzle, as shown in Fig. 19. Also, it is preferable that the nozzle is held at an acute angle of a relative to the substrate 50 in the direction of applying the fluorescent paste so that the opening of the tip of the nozzle is oriented in a direction opposite to the direction of applying the fluorescent paste. In such a case, the angle θ is set to be within the range of 30° to 60°, and the angle a is set to be within the range of 45° to 70°. This makes it possible to eject the fluorescent paste from each of the nozzles with certainty in the direction opposite to the direction of applying the fluorescent paste, thereby fixing the direction of ejection. Thus, each of the nozzles can apply the fluorescent paste with accuracy into each of the intended grooves.

The syringe 57a is attached to the syringe attachment (Fig. 4) so that each of the nozzles 56a is arranged perpendicular to the ribs. However, when a mechanism is provided for rotating the syringe 57a in a direction shown by an arrow W in Fig. 15, the rotation of the syringe 57a makes it possible to adjust the coating pitch of the nozzles 56a.

Further, it is possible to conduct fluorescent paste application similar to the one for the above-described multi-nozzle by using a head 63 shown in Fig. 20 obtained by improving the applicator head of a coating apparatus called a slot-die coater or a die-coater for applying a curtain-like paste.

The longitudinal cross-section of the head 63 is shown in Fig. 21, and the cross-section of Fig. 21 along the A-A line is shown in Fig. 22. As shown in these Figures, the head 63 includes therein a reservoir tank 57b for temporarily storing the fluorescent paste and a plurality of gaps (channels) 56b for ejecting the fluorescent paste, the gap corresponding to the nozzle 56a in Fig. 16. Through these channels 56b, the fluorescent paste is ejected in a manner like the teeth of a comb. For forming the above-described fluorescent layers of the three colors, the heads 63 corresponding to each of the three colors are arranged as mentioned above for completing the entire coating operations.

Claims

1. An apparatus for use in the manufacture of plasma display panels for applying fluorescent paste into the grooves of grooved, ribbed substrates, characterized by a paste dispenser (56, 58) comprising a nozzle (56) for ejecting fluorescent paste.

2. An apparatus according to claim 1 and comprising a platform (51) for mounting a substrate and a transporter (52-57) for moving the nozzle (56) relative to the platform (51).

3. An apparatus according to claim 2 and comprising a controller (80) for controlling the transporter (52-57) and the dispenser (56, 58).

4. An apparatus according to claim 1, 2 or 3, wherein said nozzle (56) is the only nozzle of the dispenser (58).

5. An apparatus according to claim 1, 2 or 3, wherein the dispenser (58) comprises a plurality of nozzles (56a, 63) separated from each other in one direction by a predetermined distance, whereby paste can be applied simultaneously into a plurality of mutually parallel substrate grooves.

6. An apparatus according to claim 5, wherein said predetermined distance is an integer multiple of the rib pitch of the substrates to be processed.

7. An apparatus according to claim 3, or to claim 4, 5 or 6 when appended to claim 3, wherein the controller (80) is operable to control the transporter (52-57) and the dispenser (56, 58) on the basis of a control value corresponding to a substrate rib pitch.

8. An apparatus according to claim 3 or 7, or to claim 4, 5 or 6 when appended to claim 3, wherein the

controller has a first operational mode for controlling the transporter and the dispenser, in which first mode a step of applying fluorescent paste is started while maintaining a first distance between the nozzle and the substrate and the step of applying fluorescent paste is subsequently continued with while maintaining a second distance between the nozzle and the substrate, the second distance being larger than the first distance.

9. An apparatus according to claim 8, wherein the controller has a second operational mode for substrates comprising an effective display region at a central portion thereof and an ineffective display region around the effective display region, in which second mode the controller controls the transporter and the dispenser so that the fluorescent paste is applied while maintaining over the ineffective display region the said first distance between the nozzle and the substrate and over the effective display region the said second distance.

10. An apparatus according to any one of the preceding claims and comprising a position sensor (59, 60) for detecting alignment marks and/or rib ends on substrates.

11. An apparatus according to claim 10 when appended to claim 3, wherein the controller has a third operational mode for substrates comprising an alignment mark on the surface thereof, in which third mode the controller controls the transporter and the dispenser on the basis of substrate alignment marks and/or rib tips detected by the position sensor.

12. An apparatus according to claim 11, when appended to claim 7, wherein the controller is operable to set said control value to a preset value and to correct said preset control value on the basis of substrate alignment marks and/or rib ends detected by the position sensor (59, 60).

13. An apparatus according to any one of the preceding claims and comprising a substrate height sensor (61, 62) for measuring the height of an upper surface of a substrate mounted on the apparatus.

14. An apparatus according to claim 13, when appended to claim 3, wherein the controller is operable to control the transporter (52-57) so that the distance between the nozzle (56) and a substrate mounted on the apparatus is adjustable at the time of applying fluorescent paste on the basis of height values measured by the substrate height sensor (61, 62).

15. An apparatus according to claim 13, when appended to claim 3, wherein the controller is operable to calculate a virtual curved surface representing the surface of a substrate on the basis of a measurement of the height of at least three points on the surface of such a mounted substrate, or on the ribs, by the substrate height sensor (61, 62) and is then operable to control the transporter (52-57) and the nozzle (56) during application of fluorescent paste into the grooves of such a mounted substrate such that the nozzle (56) is moved so as to be maintained parallel to the calculated virtual curved surface.

16. An apparatus according to any one of the preceding claims and comprising a paste thickness sensor (61, 62) for measuring the thickness of fluorescent paste in the grooves of a substrate mounted on the apparatus.

17. An apparatus according to claim 16, wherein the controller (80) is operable to stop the application of fluorescent paste when the thickness of the applied fluorescent paste measured by the paste thickness sensor (61, 62) deviates from a permissible range.

18. An apparatus according to any one of the preceding claims and comprising a rib end position sensor (59, 60) for detecting rib ends.

19. An apparatus according to claim 18, wherein the controller (80) has a fourth operational mode, in which fourth mode the controller (80) controls the transporter (52-57) and the nozzle (56) on the basis of the detected rib end position when a rib end is detected by the rib end position sensor (59, 60) and otherwise on the basis of a preset rib pitch valve.

20. An apparatus according to any one of the preceding claims, wherein the controller (80) is operable to control the transporter (52-57) and the dispenser (56, 58) so that the length of fluorescent paste applied to each substrate groove is shorter than the groove concerned by a preset amount (d).

21. An apparatus according to any one of the preceding claims, wherein the nozzle (56a) has an end surface formed obliquely relative to the axis of the nozzle.

22. An apparatus according to claim 21, wherein the nozzle (56) is mounted in the apparatus at an acute angle to the plane of substrate mounting in the direction of application of fluorescent paste.

23. A system comprising:

a plurality of apparatus according to any one of the preceding claims disposed in series, each apparatus being for applying fluorescent paste of a chosen color;
a paste dryer provided between each said apparatus; and

a plurality of substrate transporters provided for transporting substrates between the apparatus and the dryer or dryers.

24. A system according to claim 23 having an operational mode in which:

the apparatus consecutively apply fluorescent paste of the respective color into respective grooves of a substrate;
the dryer or dryers dry the fluorescent paste in the grooves between the ribs on the substrate to such a degree that no surface tension is generated; and
the substrate transporters transport the substrate from one of the apparatus to the apparatus adjacent thereto via one of the dryers,
so that the filling and the drying of the fluorescent paste of each color are altematively conducted, the drying process serving to allow the fluorescent layers to be deposited onto interior surfaces of the grooves between the ribs.

25. A system comprising:

a plurality of apparatus according to any one of the claims 1 to 22, each apparatus being for applying fluorescent paste of a chosen color;
a dryer for drying substrates; and
a substrate transporter for transporting substrates between each of the apparatus and the dryer.

26. A system according to claim 25, having an operational mode in which:

the apparatus consecutively apply fluorescent paste of the respective color into respective grooves of a substrate;
the dryer dries the fluorescent paste in the grooves between the ribs on the substrate to such a degree that no surface tension is generated; and
the substrate transporter transports the substrate having the fluorescent paste thereon from one of the apparatus to another of the apparatus via the dryer,
so that the filling and the drying of the fluorescent paste of each color are alternately conducted, the drying process serving to allow the fluorescent layers to be deposited onto interior surfaces of the grooves between the ribs.

27. A method of applying fluorescent pastes of different colors onto a grooved, ribbed substrate, the method comprising:

loading a plurality of paste dispensers with fluorescent pastes of respective colors;
applying via ejection from a nozzle of a first paste dispenser fluorescent paste of a first color into first grooves on the substrate surface;
drying the applied fluorescent paste of the first color;
applying via ejection from a nozzle of a second paste dispenser fluorescent paste of a second color into second grooves adjacent to the first grooves on the substrate; and
drying the applied fluorescent paste of the second color.

28. A method according to claim 27 and comprising:

applying via ejection from a nozzle of a third paste dispenser fluorescent paste of a third color into third grooves adjacent to the second grooves on the substrate on the other side from the first grooves; and
drying the applied fluorescent paste of the third color.

29. A method according to claim 27 or 28 and comprising alternately repeating the steps of applying and drying the fluorescent paste of each color.

30. A method according to claim 29, wherein each paste dispenser has a plurality of nozzles, the nozzles being spaced at a rib pitch which is an integer multiple of the number of colors, whereby the fluorescent paste of each color is simultaneously ejected to fill a plurality of different grooves on the substrate.

31. A method according to claim 29, wherein the fluorescent paste in the grooves between the adjacent ribs is deposited onto interior surfaces of the grooves to lose its surface tension in the drying step.

32. A method of applying fluorescent pastes of three different colors into grooves between a plurality of ribs spaced in parallel at a pitch P on a substrate by employing a paste dispenser comprising n nozzles spaced at a pitch of 6P, the method comprising repetition of the steps of:

(1) applying a fluorescent paste simultaneously at the pitch of 6P into n grooves with the n nozzles while moving the dispenser in a forward direction;
(2) moving the dispenser by a distance of 3P in a direction perpendicular to the ribs;
(3) applying the fluorescent paste into n grooves while moving the dispenser in a backward direction; and
(4) moving the dispenser by a distance of 3P X

(2n-1) in the direction perpendicular to the ribs.

33. A method according to claim 32, wherein the substrate to be used has such ribs that ends of an adjacent pair or ribs are alternately connected so that the ribs meander.

34. A method for applying fluorescent pastes according to claim 32, wherein the substrate to be used has such ribs that two adjacent ribs leave each other at one end of the groove therebetween and approach each other at the other end of the groove.

35. A method of manufacturing a plasma display panel comprising a fluorescent paste application method according to any one of claims 27 to 34.

36. A method of manufacturing a substrate assembly for a color plasma display panel, the manufactured substrate assembly having fluorescent pastes of three different colors, the method comprising:

a rib formation step of forming a plurality of ribs having a straight central portion and opposite ends bent in such a manner that the opposite ends are bent in opposite directions, and arranging the ribs on a substrate for the substrate assembly so that two adjacent ribs leave each other at one end of the groove therebetween and approach each other at the other end of the groove and are parallel to each other at the central portion thereof as seen from above the substrate; and
a coating step of applying a fluorescent paste of one color into a groove formed between two adjacent ribs by moving a nozzle for ejecting the fluorescent paste along the groove, the movement of the nozzle being started from an end of the groove where the two adjacent ribs leave each other,
wherein the fluorescent paste of the one color is applied into every third groove formed between ribs by consecutive reciprocating movement of the nozzle along the grooves in the coating step.

37. A substrate for a plasma display panel, the substrate having a plurality of ribs extending in a direction from one side of the substrate to the other, characterised in that the ends of adjacent pairs of ribs at the sides of the substrate are alternately interconnected by a bridging rib portion so that at least some of said ribs and bridging rib portions can be considered to form a single meandering rib.

38. A substrate according to claim 37, wherein said bridging rib portions are chevron shaped.

39. A substrate for a plasma display panel, the substrate having a plurality of ribs extending in a direction from one side of the substrate to the other, characterised in that the end regions of adjacent ribs alternately diverge and converge at each side of the substrate.

40. A plasma display panel comprising a substrate according to claim 37, 38 or 39.

Fig.1

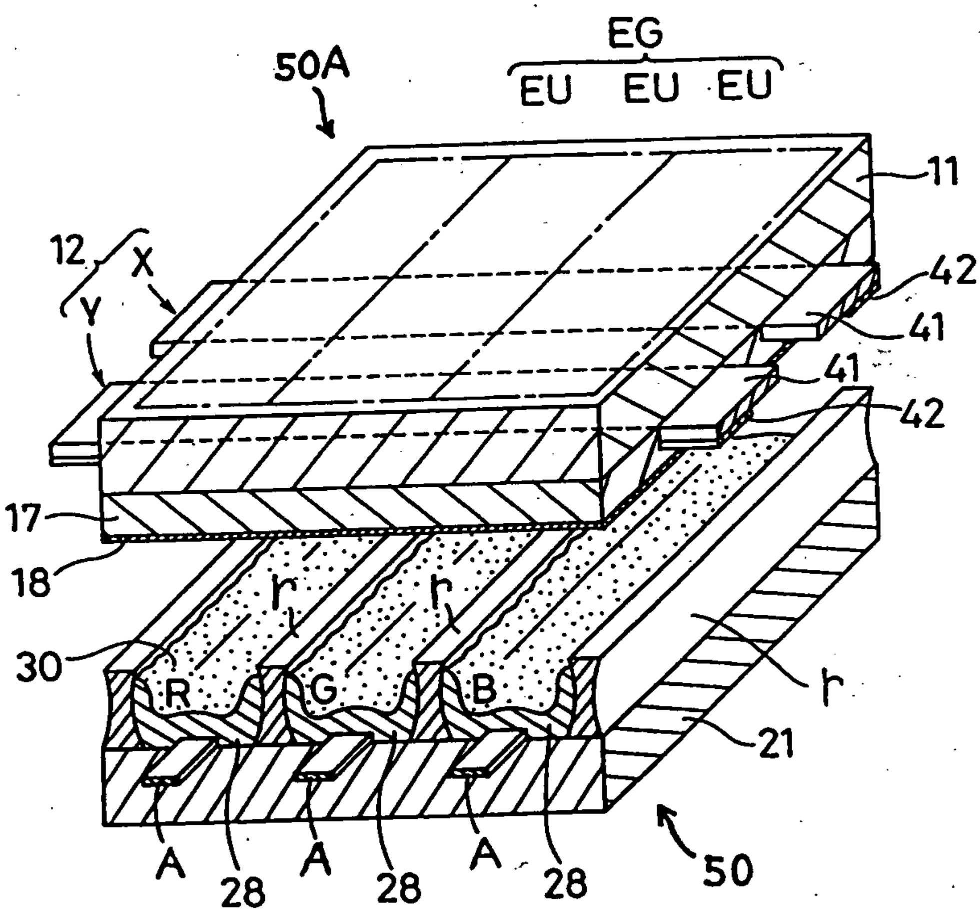

EG
EU
EU
EU
50A
11
42
41
41
42
12
X
Y
17
18
30
R
G
B
r
r
r
21
A
A
A
28
28
28
50

Fig.2

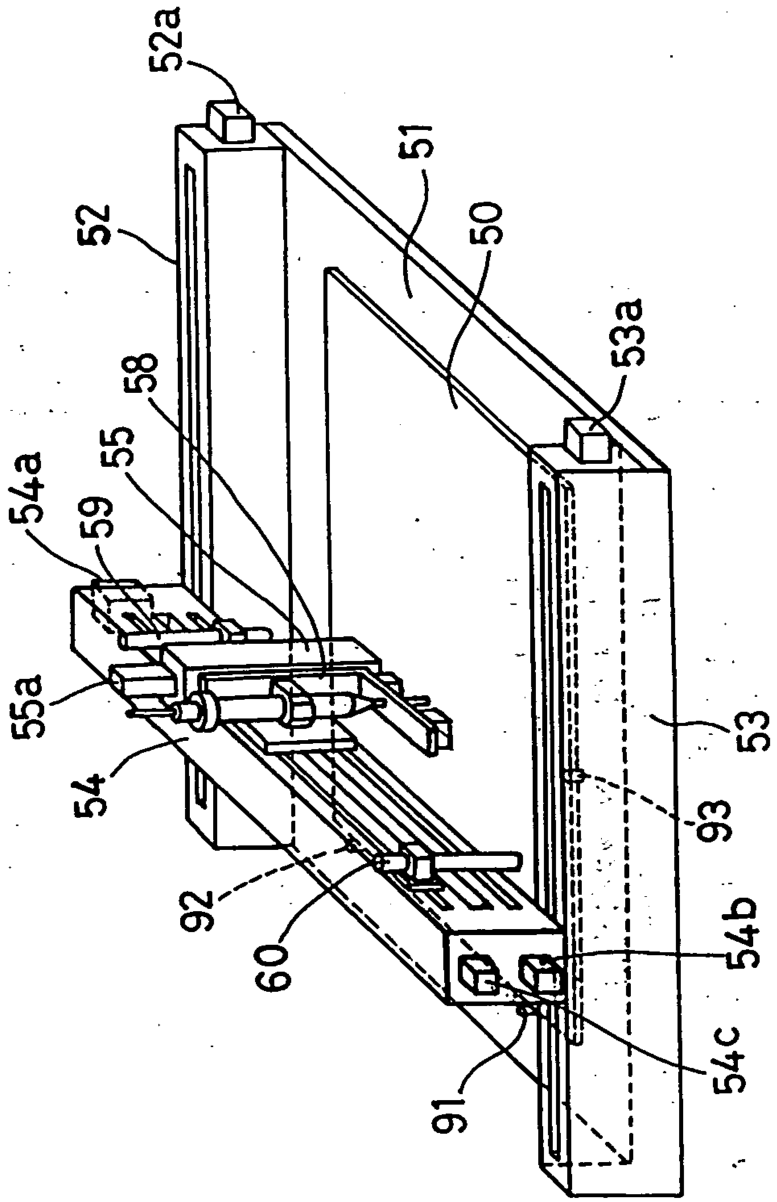


Fig.3

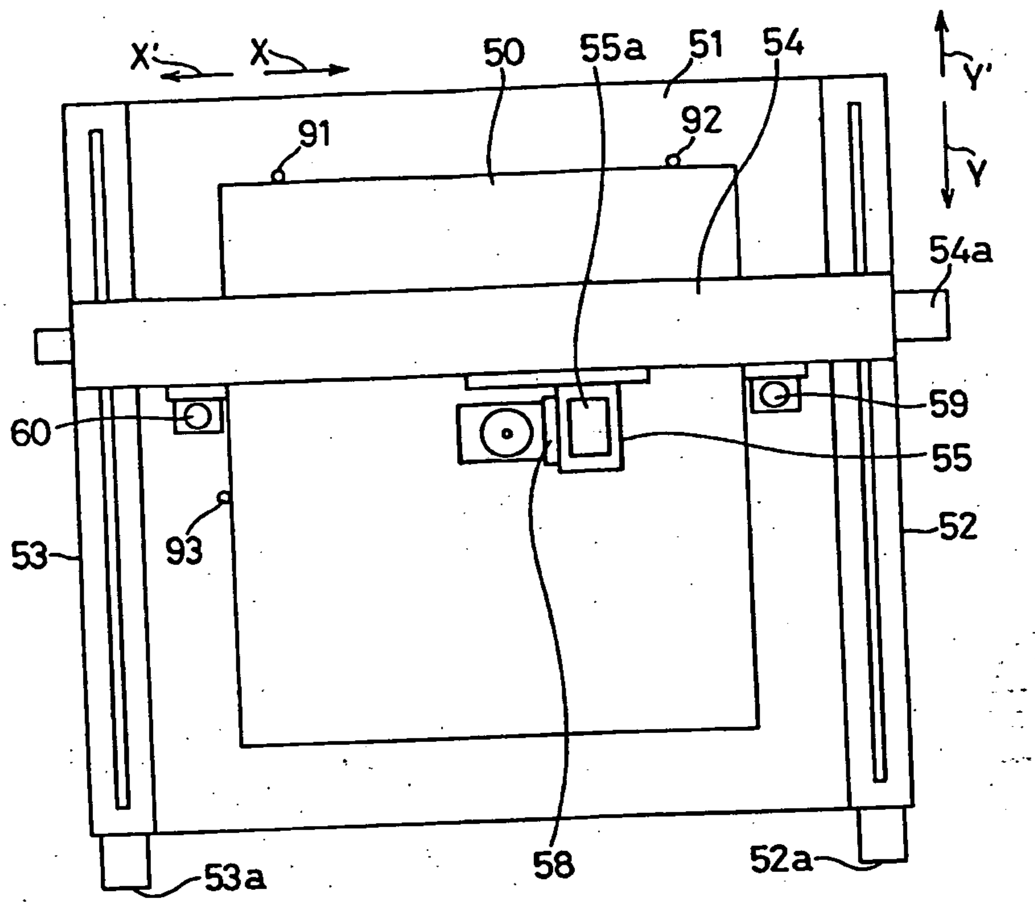

X'
X
50
55a
51
54
Y'
Y
91
92
54a
60
59
55
53
93
52
58
53a
52a

Fig.4

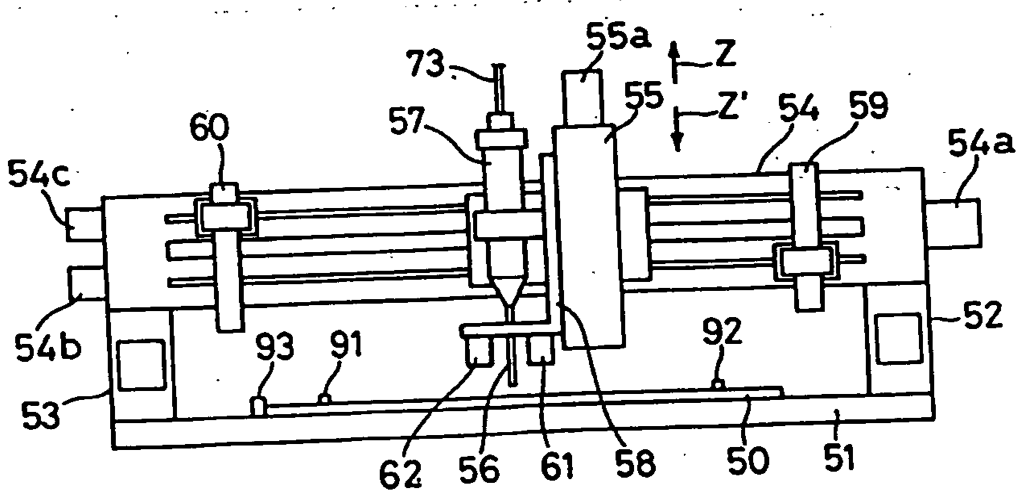
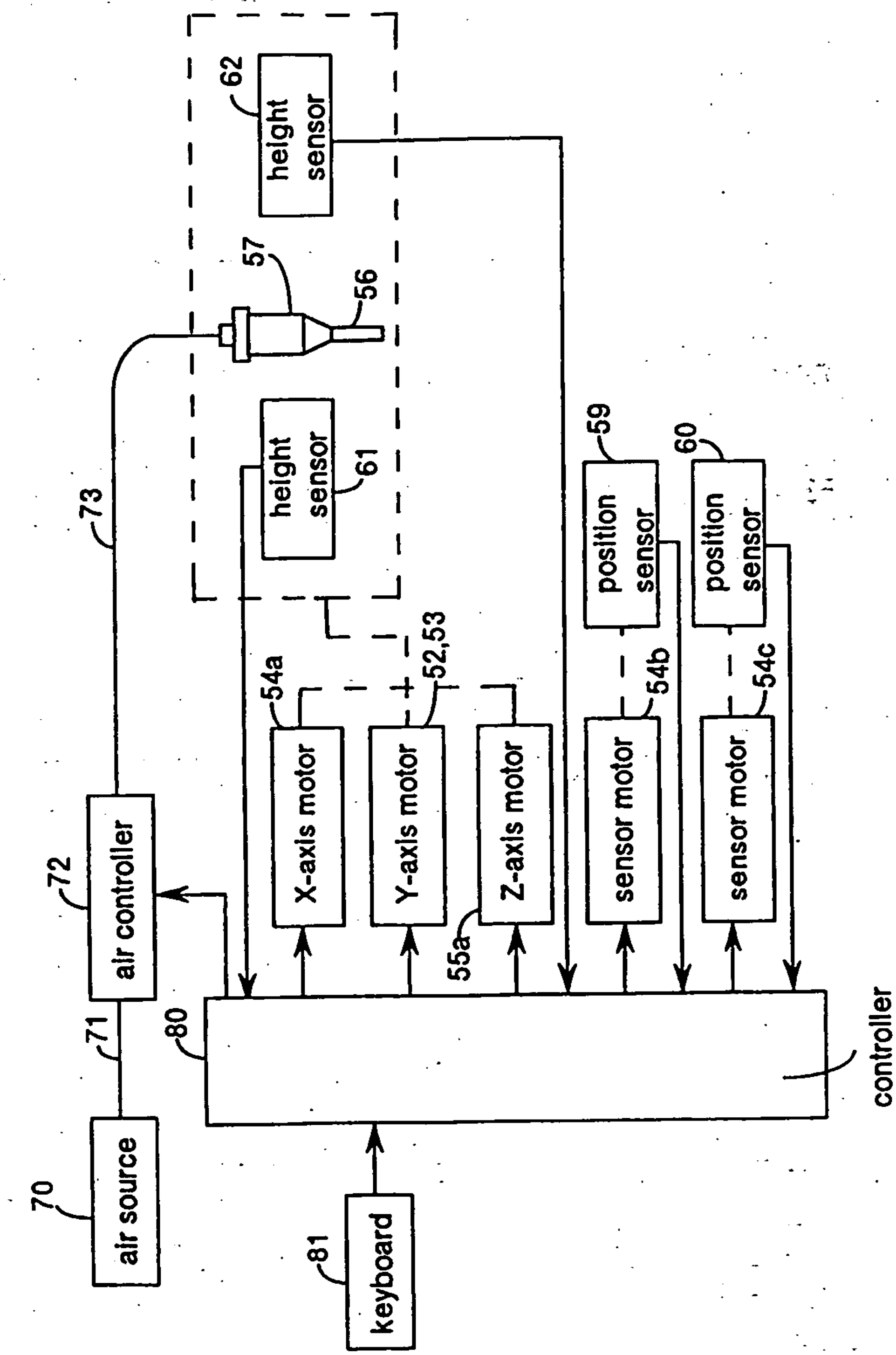

73
55a
Z
Z'
57
55
54
59
60
54a
54c
54b
93
91
92
52
53
62
56
61
58
50
51

Fig.5



62
height sensor
57
56
height sensor
61
73
position sensor
59
position sensor
60
52,53
54a
54b
54c
X-axis motor
Y-axis motor
Z-axis motor
sensor motor
sensor motor
55a
72
air controller
71
80
controller
70
air source
81
keyboard

Fig.6

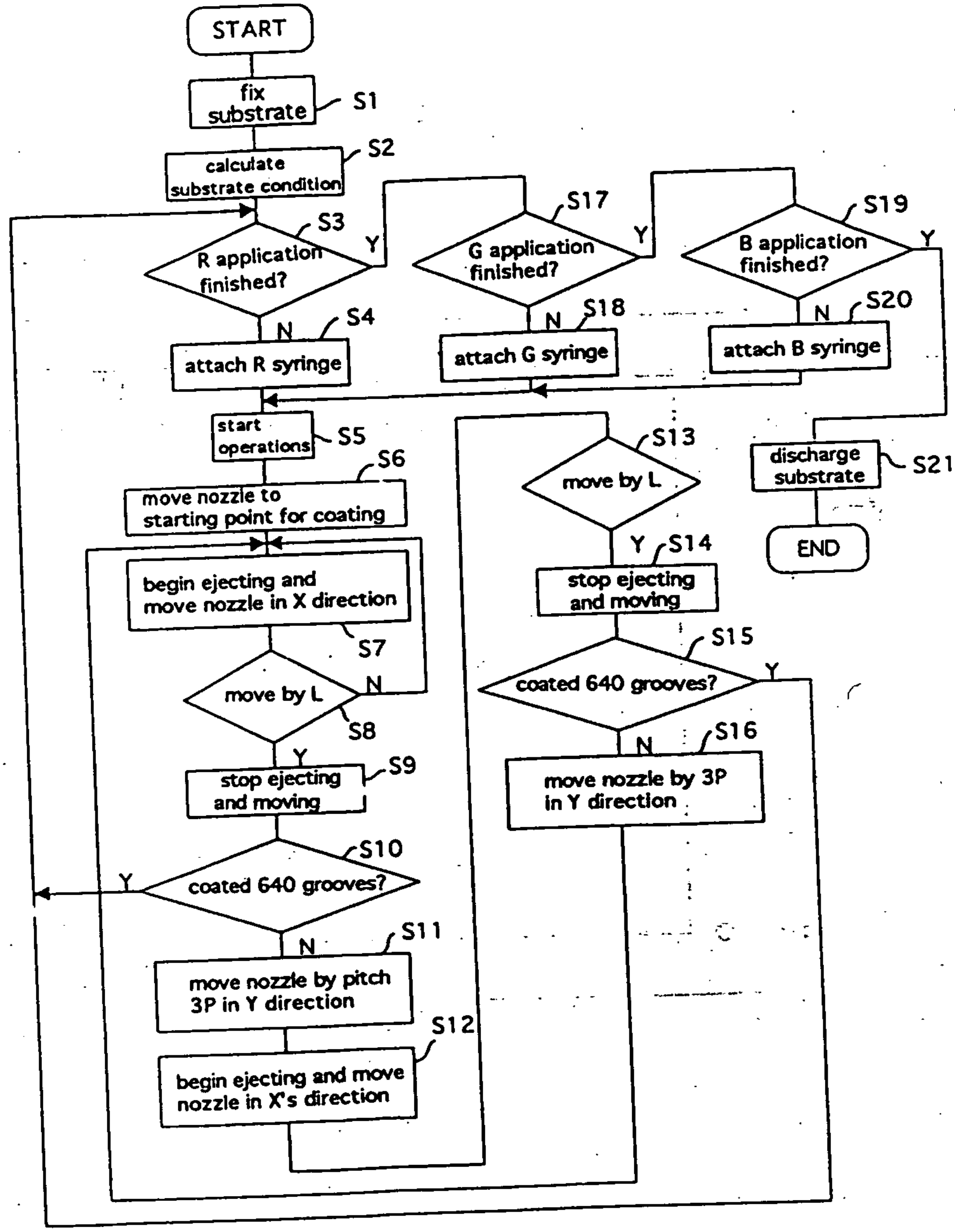

START
fix substrate
S1
calculate substrate condition
S2
R application finished?
S3
Y
N
attach R syringe
S4
G application finished?
S17
N
S18
attach G syringe
B application finished?
S19
N
S20
attach B syringe
start operations
S5
move nozzle to starting point for coating
S6
begin ejecting and move nozzle in X direction
S7
move by L
N
S8
Y
stop ejecting and moving
S9
coated 640 grooves?
S10
N
move nozzle by pitch 3P in Y direction
S11
begin ejecting and move nozzle in X's direction
S12
move by L
S13
Y
S14
stop ejecting and moving
coated 640 grooves?
S15
N
S16
move nozzle by 3P in Y direction
discharge substrate
S21
END

Fig.7

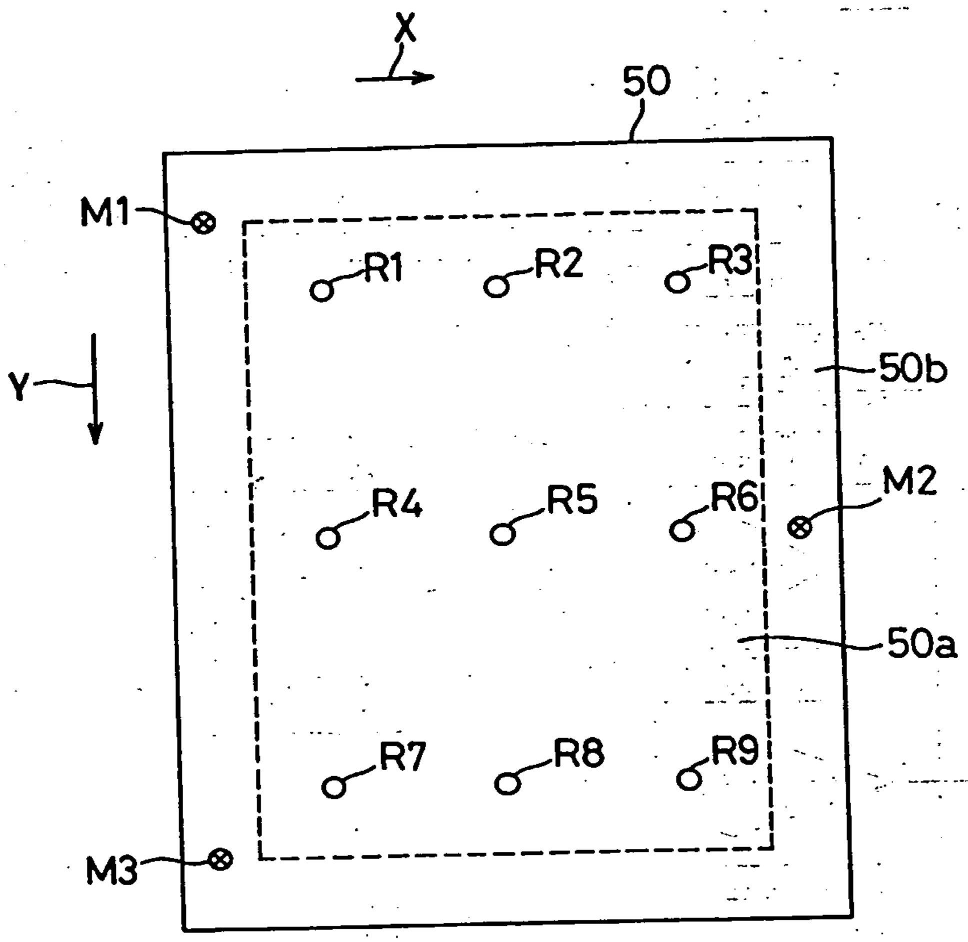


Fig.8

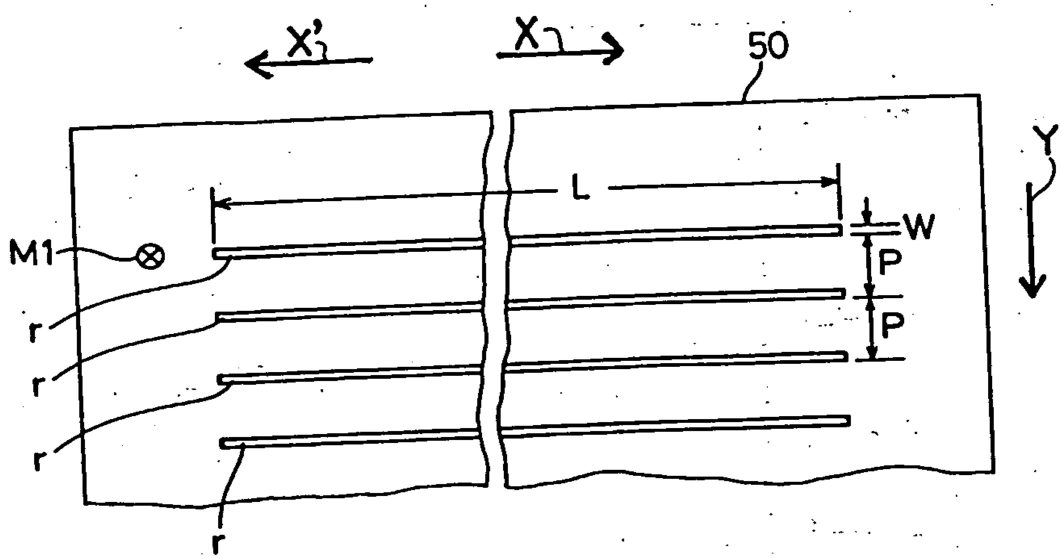


Fig.9

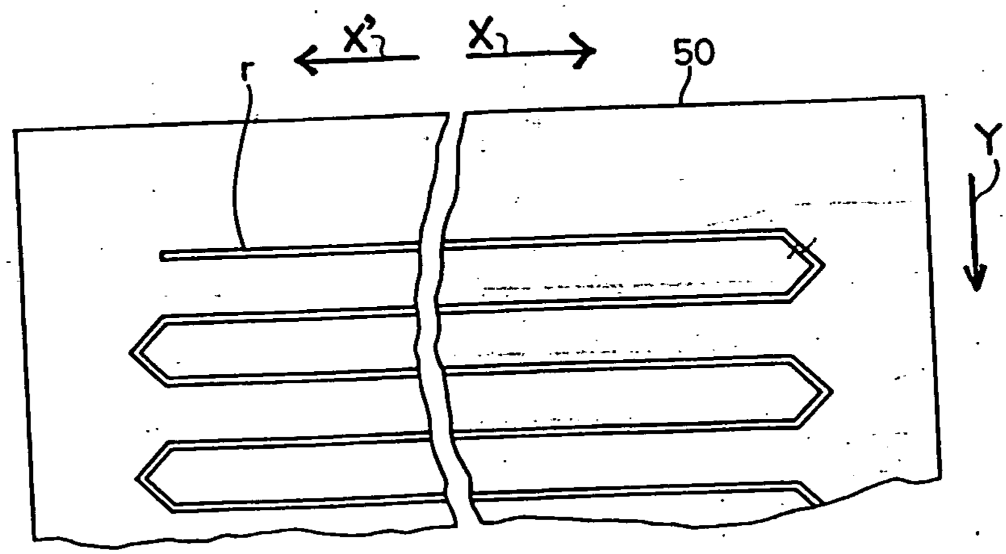


Fig.10

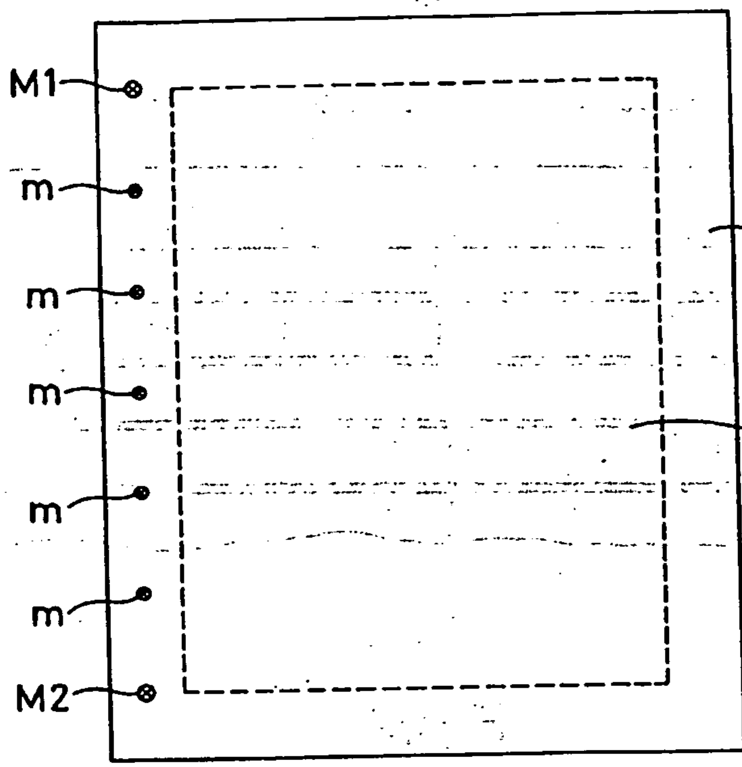


Fig.11

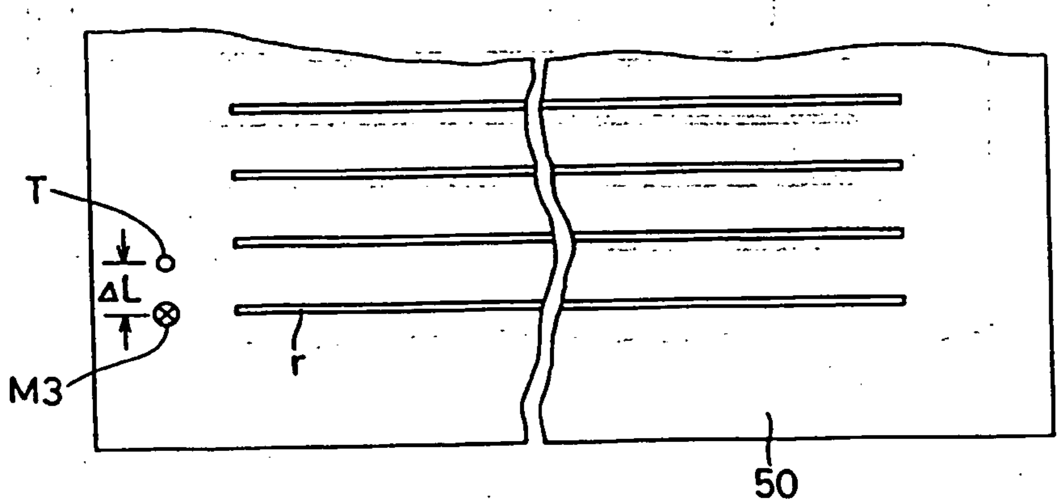


Fig.12

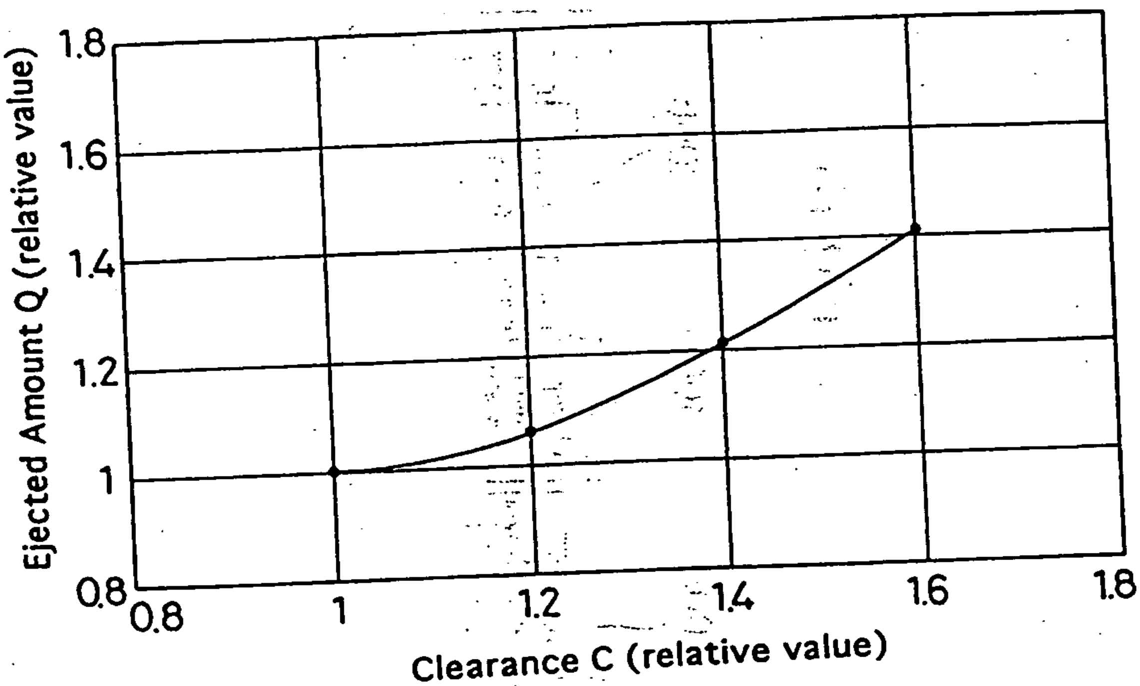

Ejected Amount Q (relative value)
1.8
1.6
1.4
1.2
1
0.8
0.8
1
1.2
1.4
1.6
1.8
Clearance C (relative value)

Fig.13

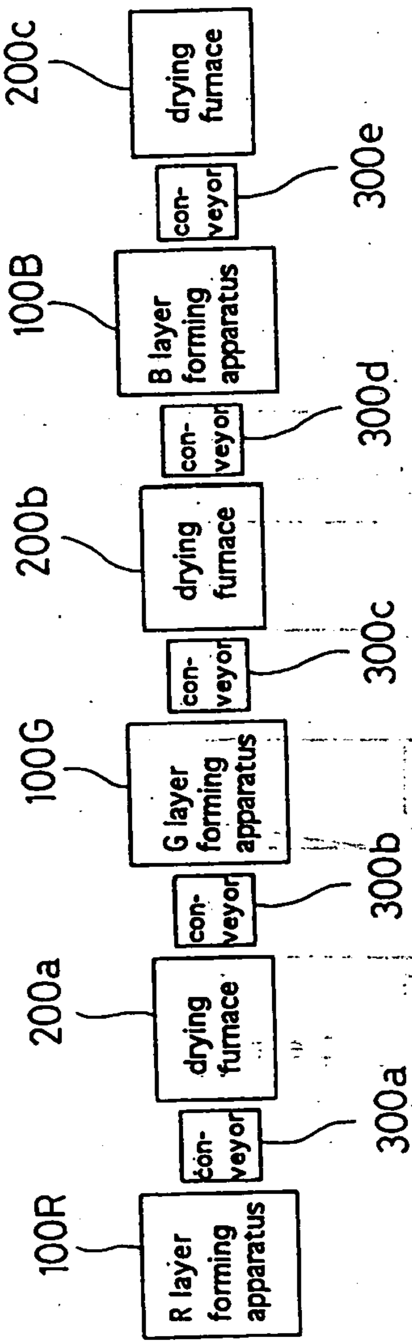

100R
R layer forming apparatus
300a
con-veyor
200a
drying furnace
300b
con-veyor
100G
G layer forming apparatus
300c
con-veyor
200b
drying furnace
300d
con-veyor
100B
B layer forming apparatus
300e
con-veyor
200c
drying furnace

Fig.14

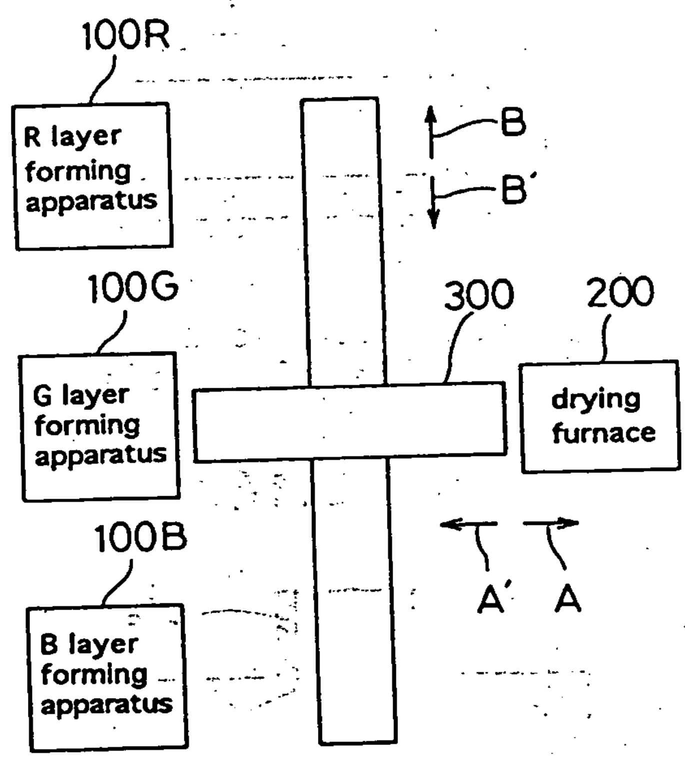

100R
R layer forming apparatus
B
B'
100G
300
200
G layer forming apparatus
drying furnace
100B
A'
A
B layer forming apparatus

Fig.15

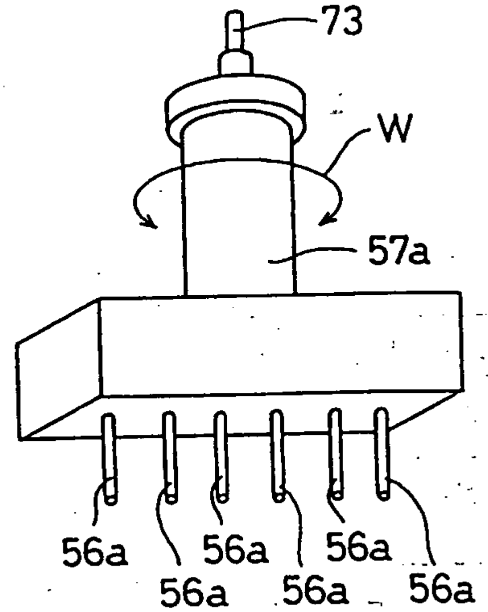


Fig.16

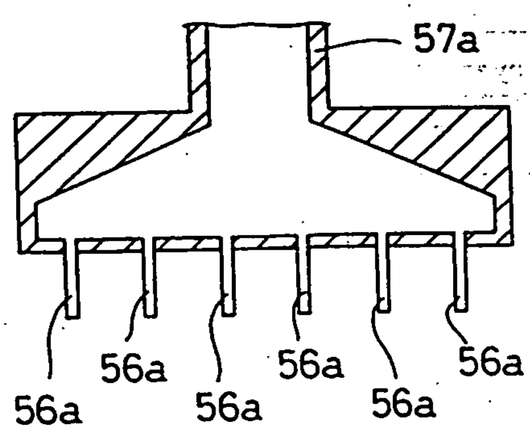


Fig.17

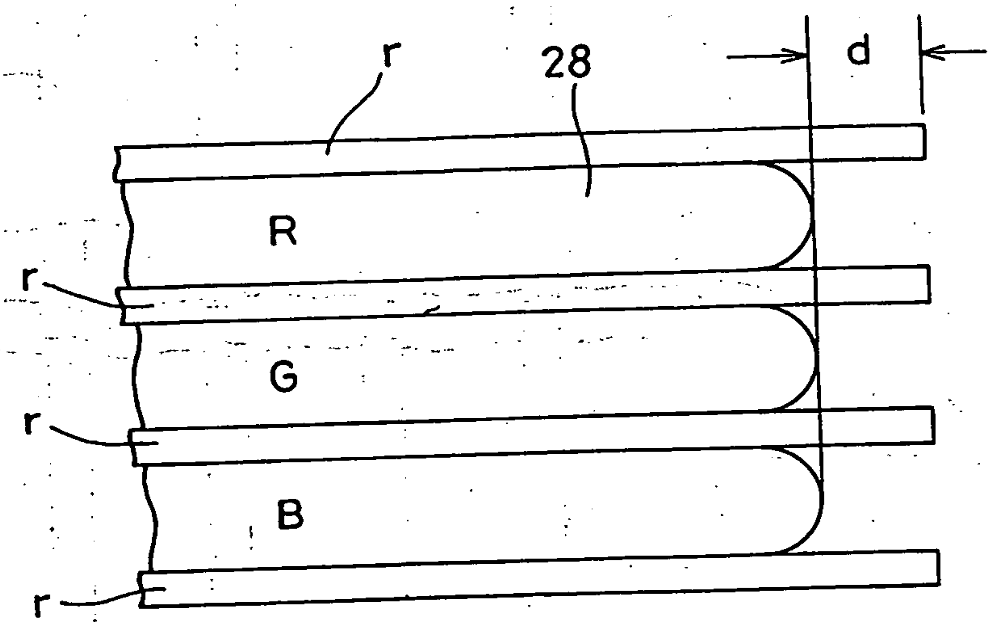


Fig.18

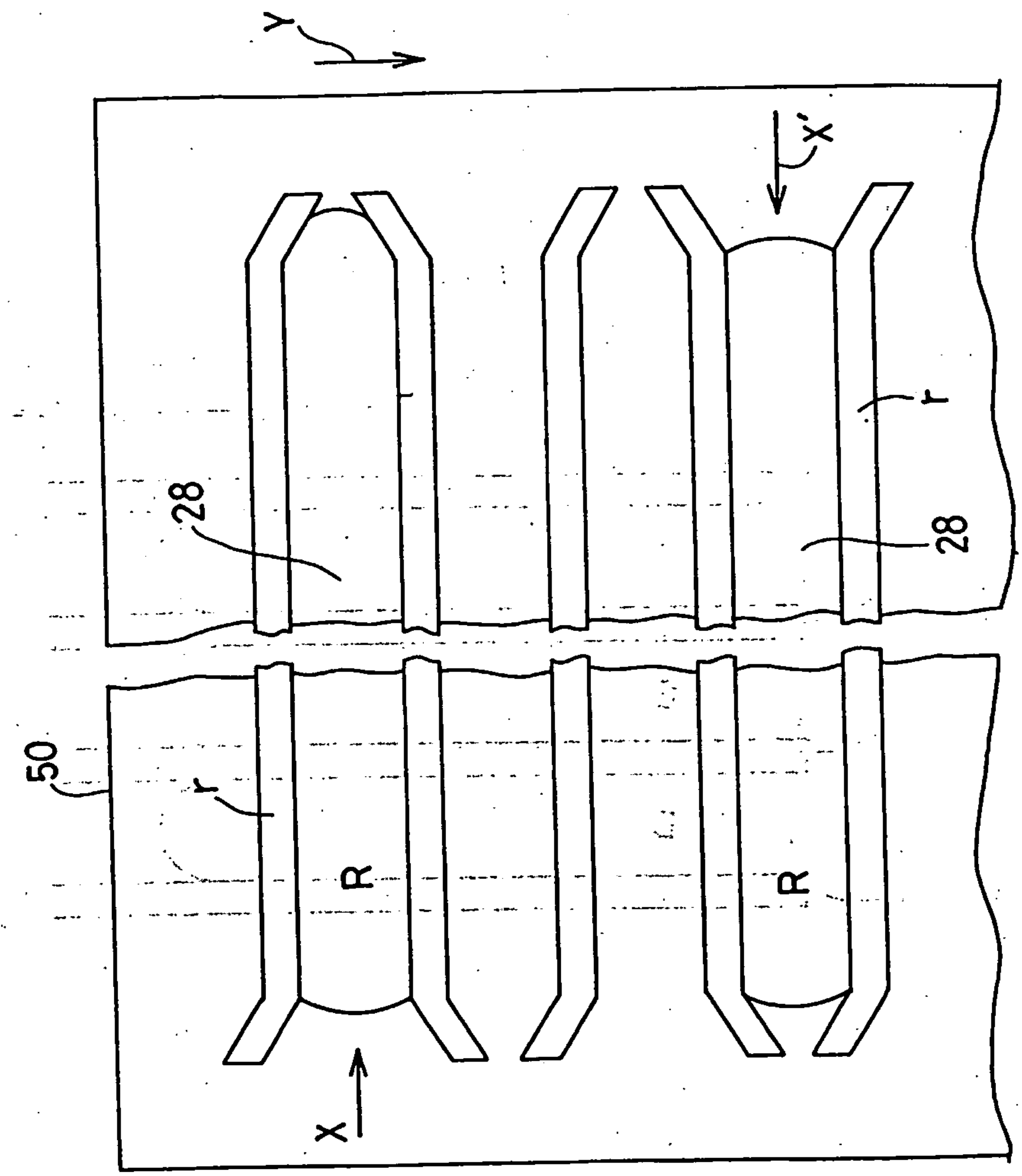


Fig.19

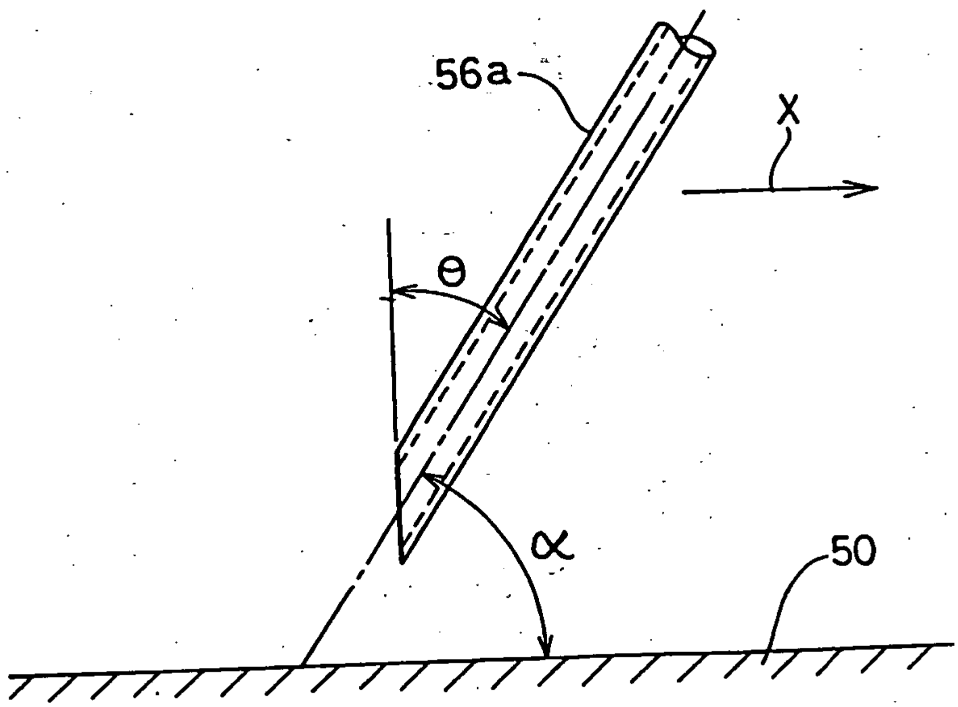


Fig.20

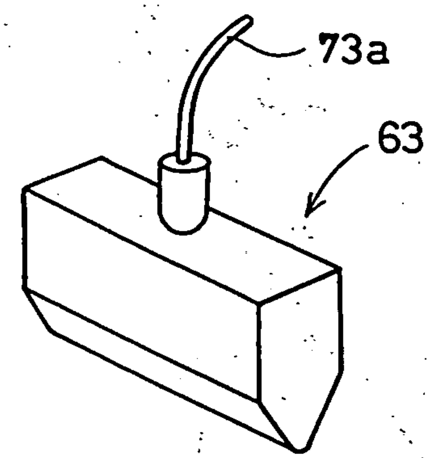


Fig.21

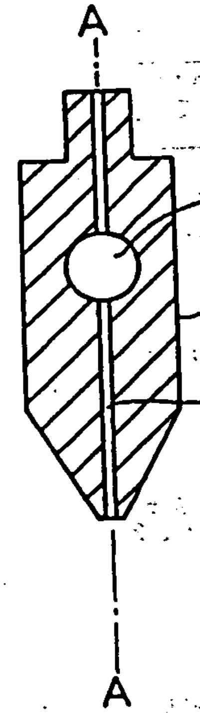
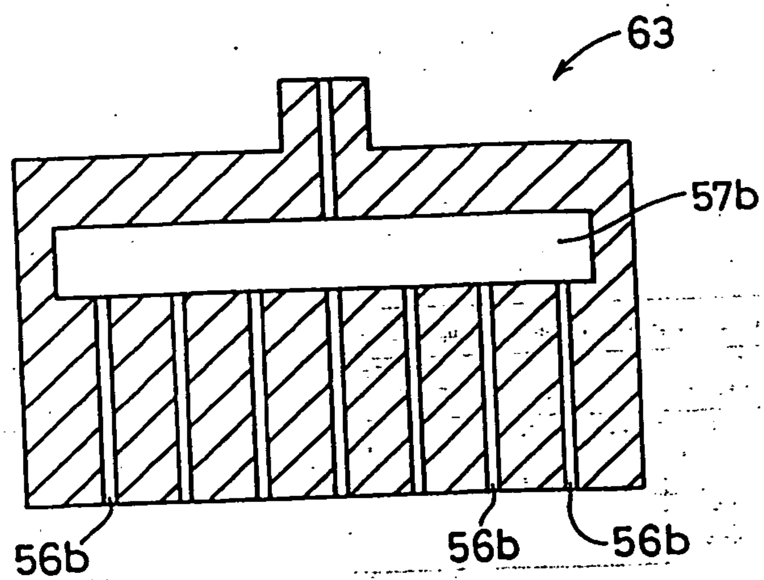


Fig.22



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 30 0660

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	PATENT ABSTRACTS OF JAPAN vol. 095, no. 004, 31 May 1995 & JP 07 021913 A (SONY CORP), 24 January 1995, * abstract *	1-22	H01J9/227 H01J17/49
A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 418 (E-678), 7 November 1988 & JP 63 155527 A (FUJITSU LTD), 28 June 1988, * abstract *	1-22	
A	PATENT ABSTRACTS OF JAPAN vol. 006, no. 164 (E-127), 27 August 1982 & JP 57 084545 A (HITACHI LTD), 26 May 1982, * abstract *	1-22	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 July 1997	Drouot, M-C

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